

Appl. No. 09/633,760
Amendment and/or Response
Reply to Office action of 5 May 2004

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Amendments to the Claims:

A listing of the entire set of pending claims (including amendments to the claims, if any) is submitted herewith per 37 CFR 1.121. This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently Amended) A method of determining a position of an unknown point in space using at least two cameras aimed to have a substantially overlapping field of view, comprising: ~~the steps of,~~

generating in each of ~~said~~the cameras an image corresponding to at least four points lying in a reference plane, the reference plane being common to the respective images of the cameras;

calculating a planar projective transform that maps ~~said~~the images of ~~said~~the at least four points to a reference frame, ~~said~~the reference frame being a projection of ~~said~~the reference plane;

generating, in each of ~~said~~the cameras, images of at least two calibration markers whose positions relative to ~~said~~the reference plane are known and an image of an unknown point;

for each of ~~said~~the images of ~~said~~the at least two calibration markers and ~~said~~the image of an unknown point, applying ~~said~~the transform to define respective points in the reference frame; and

computing at least a distance of ~~said~~the unknown point from ~~said~~the reference plane responsively to ~~said~~the points defined in ~~said~~the reference frame for ~~said~~the markers and ~~said~~the unknown point.

2. (Currently amended) A method as in claim 1, wherein ~~said step of~~ computing at least the distance of the unknown point includes computing a distance of ~~said~~the unknown point from ~~said~~the reference plane responsively to positions of ~~said~~the calibration markers.

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3. (Currently Amended) A method as in claim 2, wherein ~~said~~the positions indicate a distance of ~~said~~the calibration markers from ~~said~~the reference plane.
4. (Currently Amended) A method as in claim 1, wherein ~~said step of~~ generating ~~said~~the image of ~~said~~the calibration markers includes positioning ~~said~~the calibration markers in ~~said~~the overlapping field of view.
5. (Currently Amended) A method as in claim 4, wherein ~~said step of~~ positioning includes extending a boom with ~~said~~the markers.
6. (Currently amended) A method as in claim 1, wherein ~~said~~the position of each calibration markers includes only a distance from ~~said~~the reference plane.
7. (Currently amended) A strap-down three-dimensional reconstruction system, comprising:
a jig supporting at least two cameras;
~~said~~the jig having a structure to support at least two calibration markers in a position to be substantially visible by ~~said~~each of the at least two cameras; and
~~said~~the jig also supporting at least four reference markers in a visual field of each of ~~said~~the at least two cameras, all of ~~said~~the reference markers lying in a common plane.
8. (Currently Amended) A system as in claim 7, wherein ~~said~~the four reference markers are corners of an aperture in a screen of ~~said~~the jig.
9. (Currently Amended) A system as in claim 7, wherein ~~said~~the four reference markers are projected onto a screen.

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10. (Currently Amended) A system as in claim 7, further comprising an image processing computer connected to receive said the images from said the cameras and programmed to calculate a position of a point visible in each of said the cameras responsively to position data corresponding to said the calibration markers.

11. (Currently amended) A method of determining a position of an unknown point in space using at least two cameras aimed to have a substantially overlapping field of view, comprising the steps of,

generating in each of said the cameras an image corresponding to at least four points lying in a reference plane, the reference plane being common to the respective images of the cameras;

calculating a planar projective transform that maps said the images of said the at least four points to a reference frame, said the reference frame being a projection of said the reference plane;

generating, in each of said the cameras, images of at least two calibration markers whose positions relative to said the reference plane are known;

transforming, by said the planar projective transform, each of said the images of calibration markers;

computing optical centers of said the cameras responsively to a result of said the step of transforming;

generating in each of said the cameras an image of an unknown point and calculating a position of said the unknown point responsively to a result of said the step of computing.

12. (Currently Amended) A method as in claim 11, wherein said the step of calculating includes transforming said the images of said the unknown point using said the planar projective transform.

13-16. (Cancelled)

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17. (New) A system comprising:

a support that is configured to support at least two optical devices,

a screen that includes at least two apertures, the support being arranged such that a field of view of each of the optical devices includes a corresponding aperture of the at least two apertures and overlaps at least a field of view of at least one other of the at least two optical devices, and

a processor that is configured to determine a relative location of an object based on an image of the object in at least two fields of view and based on a substantially orthogonal image of the screen.

18. (New) The system of claim 17, further comprising:

a structure that is configured to provide one or more calibration markers positioned at two known distances from the screen,

wherein

the processor is further configured to determine a distance of the object from the screen, based on one or more images of the one or more calibration markers at the two known distances from the screen.

19. (New) The system of claim 18, wherein

the structure includes a boom that is deployable to position the one or more calibration markers at the two known distances from the screen.

20. (New) The system of claim 17, wherein

the processor determines the relative location of the object independent of any physical dimensions of the system.

21. (New) The system of claim 17, further including

at least one camera corresponding to the at least one optical device.

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22. (New) The system of claim 21, wherein
the processor determines the relative location of the object independent of optical settings of the at least one camera.
23. (New) The system of claim 17, further including
the at least one optical device.
24. (New) A method of determining a location of an object, comprising:
providing a screen with at least two apertures,
providing a substantially orthogonal image of the screen with the at least two apertures,
providing at least two images, each image including a view of edges of a corresponding aperture of the at least two apertures and a view of the object within the edges of the corresponding aperture, and
determining the location of the object relative to the screen based on the image of the screen and the at least two images.
25. (New) A method as claimed in claim 24, further including:
providing at least one image of one or more calibration markers located at two known distances from the screen, and
determining a distance of the object relative to the screen based on the at least one image of the one or more calibration markers at two known distances from the screen.
26. (New) The system of claim 24, wherein
determining the location of the object is independent of physical dimensions related to sources of the at least two images.